

APPENDIX E-4 LCC AND PAYBACK FROM ALTERNATIVE ENERGY PRICE SCENARIOS

TABLE OF CONTENTS

E-4.1 DESCRIPTION	E-4.1
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TABLES

Table E-4.1	Life-Cycle Cost and Payback for Electric Water Heaters: AEO2000 High Growth Case	E-4.2
Table E-4.2	Operating Costs for Electric Water Heaters: AEO2000 High Growth Case	E-4.2
Table E-4.3	Energy Consumption for Electric Water Heaters: AEO2000 High Growth Case	E-4.3
Table E-4.4	Life-Cycle Cost and Payback for Electric Water Heaters: AEO2000 Low Growth Case	E-4.4
Table E-4.5	Operating Costs for Electric Water Heaters: AEO2000 Low Growth Case	E-4.4
Table E-4.6	Energy Consumption for Electric Water Heaters: AEO2000 Low Growth Case	E-4.5
Table E-4.7	Life-Cycle Cost and Payback for Electric Water Heaters: GRI2000	E-4.6
Table E-4.8	Operating Costs for Electric Water Heaters: GRI2000	E-4.6
Table E-4.9	Energy Consumption for Electric Water Heaters: GRI2000	E-4.7
Table E-4.10	Life-Cycle Cost and Payback for Natural Gas Heaters: AEO2000 High Growth Case	E-4.8
Table E-4.11	Operating Costs for Natural Gas Water Heaters: AEO2000 High Growth Case	E-4.8
Table E-4.12	Energy Consumption for Natural Gas Water Heaters: AEO2000 High Growth Case	E-4.9
Table E-4.13	Life-Cycle Cost and Payback for Natural Gas Heaters: AEO2000 Low Growth Case	E-4.10
Table E-4.14	Operating Costs for Natural Gas Water Heaters: AEO2000 Low Growth Case	E-4.10
Table E-4.15	Energy Consumption for Natural Gas Water Heaters: AEO2000 Low Growth Case	E-4.11
Table E-4.16	Life-Cycle Cost and Payback for Natural Gas Heaters: GRI2000	E-4.12
Table E-4.17	Operating Costs for Natural Gas Water Heaters: GRI2000	E-4.12
Table E-4.18	Energy Consumption for Natural Gas Water Heaters: GRI2000	E-4.13
Table E-4.19	Life-Cycle Cost and Payback for LPG Water Heaters: AEO2000 High Growth Case	E-4.14
Table E-4.20	Operating Costs for LPG Water Heaters: AEO2000 High Growth Case ..	E-4.14
Table E-4.21	Energy Consumption for LPG Water Heaters: AEO2000 High Growth Case	E-4.15

Table E-4.22	Life-Cycle Cost and Payback for LPG Water Heaters:	
	AEO2000 Low Growth Case	E-4.16
Table E-4.23	Operating Costs for LPG Water Heaters: AEO2000 Low Growth Case . .	E-4.16
Table E-4.24	Energy Consumption for LPG Water Heaters:	
	AEO2000 Low Growth Case	E-4.17
Table E-4.28	Life-Cycle Cost and Payback for Oil-Fired Water Heaters:	
	AEO99 High Growth Case	E-4.18
Table E-4.29	Operating Costs for Oil-Fired Water Heaters:	
	AEO99 High Growth Case	E-4.18
Table E-4.30	Energy Consumption for Oil-Fired Water Heaters:	
	AEO99 High Growth Case	E-4.19
Table E-4.31	Life-Cycle Cost and Payback for Oil-Fired Water Heaters:	
	AEO99 Low Growth Case	E-4.20
Table E-4.32	Operating Costs for Oil-Fired Water Heaters:	
	AEO99 Low Growth Case	E-4.20
Table E-4.33	Energy Consumption for Oil-Fired Water Heaters:	
	AEO99 Low Growth Case	E-4.21
Table E-4.34	Life-Cycle Cost and Payback for Oil-Fired Water Heaters: GRI98	E-4.22
Table E-4.35	Operating Costs for Oil-Fired Water Heaters: GRI98	E-4.22
Table E-4.36	Energy Consumption for Oil-Fired Water Heaters: GRI98	E-4.23

APPENDIX E-4 LCC AND PAYBACK FROM ALTERNATIVE ENERGY PRICE SCENARIOS

E-4.1 DESCRIPTION

In order to account for future uncertainties, we applied three alternative scenarios of projected energy prices (trends by national average) to each household's average and marginal energy prices. These alternative scenarios are:

1. High economic growth (from *Annual Energy Outlook 2000*). [U.S. Department of Energy - Energy Information Administration, 1999 #874]
2. Low economic growth (from *Annual Energy Outlook 2000*)
3. Gas Research Institute's 2000 projection [Gas Research Institute, 2000 #875]

The summary tables below present the simulation results for the three alternative scenarios. They show the impacts of the different future energy projections on the life-cycle cost and payback, operating cost, and energy savings. The tables are grouped by fuel type (electric first, natural gas next, then LPG, and oil-fired last^a), and within that, by scenario, *AEO2000* High Growth, *AEO2000* Low Growth, and *GRI2000*, respectively.^b

^aWe did not update the oil-fired analysis when the RECS 1997 data became available because only a small number of households use oil-fired water heaters. Therefore, the scenarios for oil-fired water heaters presented here reflect *AE099* and *GRI98* price forecasts.

^b GRI did not project future energy prices for LPG, therefore no *GRI2000* scenarios for LPG are presented here.

**Table E-4.1 Life-Cycle Cost and Payback for Electric Water Heaters:
AEO2000 High Growth Case**

Design Option		Fraction of Population Benefitting (%)	Average LCC Savings (\$)	Median Payback (yrs)
1	Heat Traps	92	32	1.74
2	Tank Bottom Insulation	90	38	2.77
3	2" Insulation	70	36	6.24
4	2.5" Insulation	61	28	7.13
5	Plastic Tank	39	-16	10.63
6	3" Insulation	28	-76	13.80

**Table E-4.2 Operating Costs for Electric Water Heaters:
AEO2000 High Growth Case**

Design Option		Average Annual Operating Cost (\$)	Average Savings from Baseline (\$)
0	2003 Baseline	263	—
1	Heat Traps	259	4.12
2	Tank Bottom Insulation	257	5.57
3	2" Insulation	253	10.14
4	2.5" Insulation	249	13.46
5	Plastic Tank	249	14.10
6	3" Insulation	247	16.22

**Table E-4.3 Energy Consumption for Electric Water Heaters:
AEO2000 High Growth Case**

Design Option		Average Electricity Use <i>(kWh/yr)</i>	Average Energy Savings <i>(Btu/day)</i>
0	2003 Baseline	3455	—
1	Heat Traps	3398	540
2	Tank Bottom Insulation	3377	730
3	2" Insulation	3313	1330
4	2.5" Insulation	3266	1767
5	Plastic Tank	3258	1850
6	3" Insulation	3228	2129

**Table E-4.4 Life-Cycle Cost and Payback for Electric Water Heaters:
AEO2000 Low Growth Case**

Design Option		Fraction of Population Benefitting (%)	Average LCC Savings (\$)	Median Payback (yrs)
1	Heat Traps	92	30	1.85
2	Tank Bottom Insulation	88	34	2.96
3	2" Insulation	66	28	6.67
4	2.5" Insulation	57	19	7.63
5	Plastic Tank	36	-25	11.30
6	3" Insulation	25	-87	14.86

**Table E-4.5 Operating Costs for Electric Water Heaters:
AEO2000 Low Growth Case**

Design Option		Average Annual Operating Cost (\$)	Average Savings from Baseline (\$)
0	2003 Baseline	256	—
1	Heat Traps	252	3.96
2	Tank Bottom Insulation	250	5.32
3	2" Insulation	246	9.63
4	2.5" Insulation	243	12.94
5	Plastic Tank	242	13.59
6	3" Insulation	240	15.57

**Table E-4.6 Energy Consumption for Electric Water Heaters:
AEO2000 Low Growth Case**

Design Option		Average Electricity Use <i>(kWh/yr)</i>	Average Energy Savings <i>(Btu/day)</i>
0	2003 Baseline	3501	—
1	Heat Traps	3443	541
2	Tank Bottom Insulation	3423	728
3	2" Insulation	3360	1320
4	2.5" Insulation	3311	1772
5	Plastic Tank	3301	1865
6	3" Insulation	3273	2134

Table E-4.7 Life-Cycle Cost and Payback for Electric Water Heaters: GRI2000

Design Option		Fraction of Population Benefitting (%)	Average LCC Savings (\$)	Median Payback (yrs)
1	Heat Traps	92	32	1.70
2	Tank Bottom Insulation	90	37	2.76
3	2" Insulation	69	34	6.14
4	2.5" Insulation	60	26	6.99
5	Plastic Tank	39	-17	10.33
6	3" Insulation	27	-79	13.60

Table E-4.8 Operating Costs for Electric Water Heaters: GRI2000

Design Option		Average Annual Operating Cost (\$)	Average Savings from Baseline (\$)
0	2003 Baseline	270	—
1	Heat Traps	266	4.22
2	Tank Bottom Insulation	264	5.69
3	2" Insulation	260	10.33
4	2.5" Insulation	256	13.77
5	Plastic Tank	256	14.39
6	3" Insulation	253	16.51

Table E-4.9 Energy Consumption for Electric Water Heaters: GRI2000

Design Option		Average Electricity Use <i>(kWh/yr)</i>	Average Energy Savings <i>(Btu/day)</i>
0	2003 Baseline	3467	—
1	Heat Traps	3409	540
2	Tank Bottom Insulation	3389	728
3	2" Insulation	3325	1326
4	2.5" Insulation	3278	1763
5	Plastic Tank	3270	1845
6	3" Insulation	3241	2115

**Table E-4.10 Life-Cycle Cost and Payback for Natural Gas Heaters:
AEO2000 High Growth Case**

Design Option		Fraction of Population Benefitting (%)	Average LCC Savings (\$)	Median Payback (yrs)
1	Heat Traps	96	16	1.30
2	78% RE	76	7	3.29
3	78% RE, 2" Insulation	79	34	3.48
4	78% RE, 2.5" Insulation	66	16	4.96
5	80% RE, 2" Insulation	83	-10	2.80
6	80% RE, 2.5" Insulation	72	-29	4.08
7	80% RE, 3" Insulation	50	-89	6.71
8	Side Arm	20	-233	11.74

**Table E-4.11 Operating Costs for Natural Gas Water Heaters:
AEO2000 High Growth Case**

Design Option		Average Annual Operating Cost (\$)	Average Savings from Baseline (\$)
0	2003 Baseline	165	—
1	Heat Traps	163	2.90
2	78% RE	160	5.38
3	78% RE, 2" Insulation	152	13.14
4	78% RE, 2.5" Insulation	151	14.64
5	80% RE, 2" Insulation	149	16.26
6	80% RE, 2.5" Insulation	148	17.79
7	80% RE, 3" Insulation	147	18.76
8	Side Arm	130	35.12

**Table E-4.12 Energy Consumption for Natural Gas Water Heaters:
AEO2000 High Growth Case**

Design Option		Average Energy Use		Average Energy Savings (Btu/day)
		(MMBtu/yr)	(kWh/yr)	
0	2003 Baseline	23.4	0.0	—
1	Heat Traps	23.0	0.0	1320
2	78% RE	22.5	0.0	2455
3	78% RE, 2" Insulation	21.2	0.0	5996
4	78% RE, 2.5" Insulation	21.0	0.0	6683
5	80% RE, 2" Insulation	20.7	0.0	7422
6	80% RE, 2.5" Insulation	20.5	0.0	8114
7	80% RE, 3" Insulation	20.3	0.0	8565
8	Side Arm	16.9	21.8	17817

**Table E-4.13 Life-Cycle Cost and Payback for Natural Gas Heaters:
AEO2000 Low Growth Case**

Design Option		Fraction of Population Benefitting (%)	Average LCC Savings (\$)	Median Payback (yrs)
1	Heat Traps	95	15	1.37
2	78% RE	74	4	3.47
3	78% RE, 2" Insulation	77	28	3.67
4	78% RE, 2.5" Insulation	62	8	5.23
5	80% RE, 2" Insulation	81	-19	2.95
6	80% RE, 2.5" Insulation	70	-38	4.30
7	80% RE, 3" Insulation	47	-99	7.07
8	Side Arm	17	-252	12.40

**Table E-4.14 Operating Costs for Natural Gas Water Heaters:
AEO2000 Low Growth Case**

Design Option		Average Annual Operating Cost (\$)	Average Savings from Baseline (\$)
0	2003 Baseline	157	—
1	Heat Traps	154	2.75
2	78% RE	152	5.10
3	78% RE, 2" Insulation	145	12.47
4	78% RE, 2.5" Insulation	143	13.89
5	80% RE, 2" Insulation	142	15.43
6	80% RE, 2.5" Insulation	140	16.87
7	80% RE, 3" Insulation	139	17.80
8	Side Arm	124	33.16

**Table E-4.15 Energy Consumption for Natural Gas Water Heaters:
AEO2000 Low Growth Case**

Design Option		Average Energy Use		Average Energy Savings (Btu/day)
		<i>(MMBtu/yr)</i>	<i>(kWh/yr)</i>	
0	2003 Baseline	23.4	0.0	—
1	Heat Traps	23.0	0.0	1320
2	78% RE	22.5	0.0	2455
3	78% RE, 2" Insulation	21.2	0.0	5996
4	78% RE, 2.5" Insulation	21.0	0.0	6683
5	80% RE, 2" Insulation	20.7	0.0	7422
6	80% RE, 2.5" Insulation	20.5	0.0	8114
7	80% RE, 3" Insulation	20.3	0.0	8565
8	Side-Arm	16.9	21.8	17817

Table E-4.16 Life-Cycle Cost and Payback for Natural Gas Heaters: GRI2000

Design Option		Fraction of Population Benefitting (%)	Average LCC Savings (\$)	Median Payback (yrs)
1	Heat Traps	95	13	1.43
2	78% RE	71	1	3.64
3	78% RE, 2" Insulation	74	21	3.84
4	78% RE, 2.5" Insulation	58	0	5.47
5	80% RE, 2" Insulation	80	-27	3.09
6	80% RE, 2.5" Insulation	66	-47	4.50
7	80% RE, 3" Insulation	43	-109	7.41
8	Side Arm	13	-275	13.11

Table E-4.17 Operating Costs for Natural Gas Water Heaters: GRI2000

Design Option		Average Annual Operating Cost (\$)	Average Savings from Baseline (\$)
0	2003 Baseline	150	—
1	Heat Traps	147	2.63
2	78% RE	145	4.87
3	78% RE, 2" Insulation	138	11.91
4	78% RE, 2.5" Insulation	137	13.26
5	80% RE, 2" Insulation	135	14.73
6	80% RE, 2.5" Insulation	134	16.12
7	80% RE, 3" Insulation	133	17.00
8	Side Arm	119	31.36

Table E-4.18 Energy Consumption for Natural Gas Water Heaters: GRI2000

Design Option		Average Energy Use		Average Energy Savings (Btu/day)
		(MMBtu/yr)	(kWh/yr)	
0	2003 Baseline	23.4	0.0	—
1	Heat Traps	23.0	0.0	1320
2	78% RE	22.5	0.0	2455
3	78% RE, 2" Insulation	21.2	0.0	5996
4	78% RE, 2.5" Insulation	21.0	0.0	6683
5	80% RE, 2" Insulation	20.7	0.0	7422
6	80% RE, 2.5" Insulation	20.5	0.0	8114
7	80% RE, 3" Insulation	20.3	0.0	8565
8	Side Arm	16.9	21.8	17817

E-4.1 DESCRIPTION E-4.1

Table E-4.19 Life-Cycle Cost and Payback for LPG Water Heaters: AEO2000 High Growth Case

Design Option		Fraction of Population Benefitting (%)	Average LCC Savings (\$)	Median Payback (yrs)
1	Heat Traps	98	34	1.02
2	78% RE	83	33	2.68
3	78% RE, 2" Insulation	89	99	2.79
4	78% RE, 2.5" Insulation	79	80	3.92
5	80% RE, 2" Insulation	89	65	2.26
6	80% RE, 2.5" Insulation	83	45	3.26
7	80% RE, 3" Insulation	62	-23	5.08
8	Side Arm	37	-115	8.26

Table E-4.20 Operating Costs for LPG Water Heaters: AEO2000 High Growth Case

Design Option		Average Annual Operating Cost (\$)	Average Savings from Baseline (\$)
0	2003 Baseline	259	—
1	Heat Traps	253	5.64
2	78% RE	249	10.01
3	78% RE, 2" Insulation	234	24.81
4	78% RE, 2.5" Insulation	231	27.77
5	80% RE, 2" Insulation	228	30.76
6	80% RE, 2.5" Insulation	225	33.68
7	80% RE, 3" Insulation	224	35.44
8	Side Arm	188	71.18

Table E-4.21 Energy Consumption for LPG Water Heaters: AEO2000 High Growth Case

Design Option		Average Energy Use		Average Energy Savings (Btu/day)
		(MMBtu/yr)	(kWh/yr)	
0	2003 Baseline	22.8	0.0	—
1	Heat Traps	22.3	0.0	1371
2	78% RE	21.9	0.0	2412
3	78% RE, 2" Insulation	20.6	0.0	6005
4	78% RE, 2.5" Insulation	20.4	0.0	6722
5	80% RE, 2" Insulation	20.1	0.0	7429
6	80% RE, 2.5" Insulation	19.9	0.0	8141
7	80% RE, 3" Insulation	19.7	0.0	8570
8	Side Arm	16.2	21.3	18055

Table E-4.22 Life-Cycle Cost and Payback for LPG Water Heaters: AEO2000 Low Growth Case

Design Option		Fraction of Population Benefitting (%)	Average LCC Savings (\$)	Median Payback (yrs)
1	Heat Traps	98	33	1.04
2	78% RE	83	31	2.73
3	78% RE, 2" Insulation	89	94	2.85
4	78% RE, 2.5" Insulation	78	75	4.00
5	80% RE, 2" Insulation	88	59	2.30
6	80% RE, 2.5" Insulation	82	39	3.32
7	80% RE, 3" Insulation	61	-30	5.19
8	Side Arm	36	-129	8.42

Table E-4.23 Operating Costs for LPG Water Heaters: AEO2000 Low Growth Case

Design Option		Average Annual Operating Cost (\$)	Average Savings from Baseline (\$)
0	2003 Baseline	254	—
1	Heat Traps	248	5.53
2	78% RE	244	9.81
3	78% RE, 2" Insulation	230	24.33
4	78% RE, 2.5" Insulation	227	27.23
5	80% RE, 2" Insulation	224	30.16
6	80% RE, 2.5" Insulation	221	33.02
7	80% RE, 3" Insulation	219	34.74
8	Side Arm	184	69.77

Table E-4.24 Energy Consumption for LPG Water Heaters: AEO2000 Low Growth Case

Design Option		Average Energy Use		Average Energy Savings (Btu/day)
		(MMBtu/yr)	(kWh/yr)	
0	2003 Baseline	22.8	0.0	—
1	Heat Traps	22.3	0.0	1371
2	78% RE	21.9	0.0	2412
3	78% RE, 2" Insulation	20.6	0.0	6005
4	78% RE, 2.5" Insulation	20.4	0.0	6722
5	80% RE, 2" Insulation	20.1	0.0	7429
6	80% RE, 2.5" Insulation	19.9	0.0	8141
7	80% RE, 3" Insulation	19.7	0.0	8570
8	Side-Arm	16.2	21.3	18055

**Table E-4.28 Life-Cycle Cost and Payback for Oil-Fired Water Heaters:
AEO99 High Growth Case**

Design Option		Fraction of Population Benefitting (%)	Average LCC Savings (\$)	Median Payback (yrs)
1	Heat Traps	26	-16	8.11
2	2" Insulation	7	-45	12.30
3	2.5" Insulation	3	-72	14.10
4	3" Insulation	1	-103	16.40
5	78% RE	0	-209	19.80
6	Interrupted Ignition	1	-241	19.20
7	Increased HX Area	0	-457	24.2

**Table E-4.29 Operating Costs for Oil-Fired Water Heaters:
AEO99 High Growth Case**

Design Option		Average Annual Operating Cost (\$)	Average Savings from Baseline (\$)
1	2003 Baseline	250	—
2	Heat Traps	248	2.21
3	2" Insulation	242	8.18
4	2.5" Insulation	241	9.52
5	3" Insulation	240	10.42
6	78% RE	234	16.22
7	Interrupted Ignition	230	20.39
8	Increased HX Area	223	27.55

**Table E-4.30 Energy Consumption for Oil-Fired Water Heaters:
AEO99 High Growth Case**

Design Option		Average Energy Use		Average Energy Savings (Btu/day)
		(MMBtu/yr)	(kWh/yr)	
0	2003 Baseline	25.4	75.0	—
1	Heat Traps	25.1	74.0	920
34	2" Insulation	24.2	71.4	3411
3	2.5" Insulation	24.0	70.8	3971
4	3" Insulation	23.9	70.4	4346
5	78% RE	23.0	67.8	6773
6	Interrupted Ignition	23.0	25.5	7169
7	Increased HX Area	21.9	24.4	10230

**Table E-4.31 Life-Cycle Cost and Payback for Oil-Fired Water Heaters:
AEO99 Low Growth Case**

Design Option		Fraction of Population Benefitting (%)	Average LCC Savings (\$)	Median Payback (yrs)
1	Heat Traps	25	-16	8.24
2	2" Insulation	7	-46	12.50
3	2.5" Insulation	3	-73	14.40
4	3" Insulation	1	-104	16.70
5	78% RE	0	-210	20.10
6	Interrupted Ignition	0	-244	19.60
7	Increased HX Area	0	-461	24.7

**Table E-4.32 Operating Costs for Oil-Fired Water Heaters:
AEO99 Low Growth Case**

Design Option		Average Annual Operating Cost (\$)	Average Savings from Baseline (\$)
1	2003 Baseline	247	—
2	Heat Traps	245	2.17
3	2" Insulation	239	8.05
4	2.5" Insulation	238	9.37
5	3" Insulation	237	10.25
6	78% RE	232	15.96
7	Interrupted Ignition	228	19.91
8	Increased HX Area	221	26.96

**Table E-4.33 Energy Consumption for Oil-Fired Water Heaters:
AEO99 Low Growth Case**

Design Option		Average Energy Use		Average Energy Savings (Btu/day)
		(MMBtu/yr)	(kWh/yr)	
0	2003 Baseline	25.4	75.0	—
1	Heat Traps	25.1	74.0	920
2	2" Insulation	24.2	71.4	3411
3	2.5" Insulation	24.0	70.8	3971
4	3" Insulation	23.9	70.4	4346
5	78% RE	23.0	67.8	6773
6	Interrupted Ignition	23.0	25.5	7169
7	Increased HX Area	21.9	24.4	10230

Table E-4.34 Life-Cycle Cost and Payback for Oil-Fired Water Heaters: GRI98

Design Option		Fraction of Population Benefitting (%)	Average LCC Savings (\$)	Median Payback (yrs)
1	Heat Traps	20	-18	10.1
2	2" Insulation	3	-54	15.3
3	2.5" Insulation	1	-82	17.7
4	3" Insulation	0	-114	20.6
5	78% RE	0	-226	24.7
6	Interrupted Ignition	0	-259	22.8
7	Increased HX Area	0	-482	29.3

Table E-4.35 Operating Costs for Oil-Fired Water Heaters: GRI98

Design Option		Average Annual Operating Cost (\$)	Average Savings from Baseline (\$)
1	2003 Baseline	217	—
2	Heat Traps	215	1.77
3	2" Insulation	210	6.54
4	2.5" Insulation	209	7.62
5	3" Insulation	208	8.33
6	78% RE	204	12.98
7	Interrupted Ignition	199	17.17
8	Increased HX Area	194	22.85

Table E-4.36 Energy Consumption for Oil-Fired Water Heaters: GRI98

Design Option		Average Energy Use		Average Energy Savings (Btu/day)
		(MMBtu/yr)	(kWh/yr)	
0	2003 Baseline	25.4	75.0	—
1	Heat Traps	25.1	74.0	920
2	2" Insulation	24.2	71.4	3411
3	2.5" Insulation	24.0	70.8	3971
4	3" Insulation	23.9	70.4	4346
5	78% RE	23.0	67.8	6773
6	Interrupted Ignition	23.0	25.5	7169
7	Increased HX Area	21.9	24.4	10230

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